

# The emergence of digitalised small-scale production networks in the global South

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## 1. Introduction

One of the major emerging industrial changes after the late 2000s global recession is the increasing digitalisation and automation of manufacturing processes, such as robotics, 3D printing, AI and industrial Internet of Things. While the development and implementation of these technologies is led and promoted by many industrialised nations, some bleak predictions have also been made for the rest of the world as a result of this increasing automation.

It is estimated that in the world, AI and robotics will make 800 million jobs redundant by 2030, and emerging economies such as China and India could be hit the hardest, losing 236 and 120 million jobs by 2030 respectively (Manyika et al., 2017). The costs of operating robots and 3D printers in furniture manufacturing in the US is predicted to be cheaper than Kenyan wages in 2033 (Banga and Velde, 2018), indicating that the technological unemployment in labour-intensive manufacturing industries may happen and lower labour cost may no longer be the main attribute ensuring competitiveness in a global market.

Given that industrialisation has long been considered a key factor in the economic growth of developing countries, the implications of this transformation have been mainly discussed in manufacturing, albeit with negative connotations. Technological unemployment in labour-intensive industries is expected to happen, and lower labour cost may no longer be the main attribute ensuring competitiveness in a global market. Scholars have increasingly been discussing the changing patterns and geography of production, such as premature de-industrialisation in developing countries, re-shoring manufacturing back to high-income countries and de-internationalisation (Hallward-Driemeier and Nayyar, 2018).

Despite these challenges, some believe this transformation will open “windows of opportunity” to find and foster an alternative economic development model, while the global economic environment is adjusting to these changes.

Based on interviews conducted with makerspaces, their production partners and start-ups in Vietnam, this paper introduces how small-scale production networks in developing countries are forming and growing in parallel with this industrial transformation. What we observed is the rise of a network of actors at the periphery, slipping off from conventional production sites: individuals who innovate using ready-made technology platforms to “manufacture without a firm” (Doussard et al., 2017); production partners who facilitate more on-demand, on-location small-batch product delivery; and local firms which specifically provide customised products and services aiming to digitalise the industrial practices of local SMEs. While there is extremely limited evidence to suggest that this practice could or may overtake the mass production model in the future, we argue that understanding how to foster this small-scale production network is essential to supporting an innovative and more inclusive industrial digitalisation in the global South.

## 2. Literature review

As digital technologies increasingly permeate all aspects of the physical world, many believe that we are moving into a hyper-connected, intelligent society and economy. One central concept to explain the imminent changes in manufacturing and production processes is the Fourth Industrial Revolution, or Industry 4.0.

As illustrated in Figure 1, each industrial revolution is thought to shift the manufacturing opportunities and patterns of specialisation. The vision of Industry 4.0 includes digitising all elements of the value chain to achieve a highly flexible, distributed production and service network. Through advanced technologies such as automation, artificial intelligence, robotics, 3D printing and Internet of Things in manufacturing processes, the cyber-physical system allows a tighter integration of computational and physical elements, eventually leading to machine to machine interactions and a mode of operation which provides more efficient production with limited human presence. Flexible production also allows mass customisation of individualised goods as opposed to mass manufacturing of identical goods (Sniderman et al., 2017; Hallward-Driemeier and Nayyar, 2018).

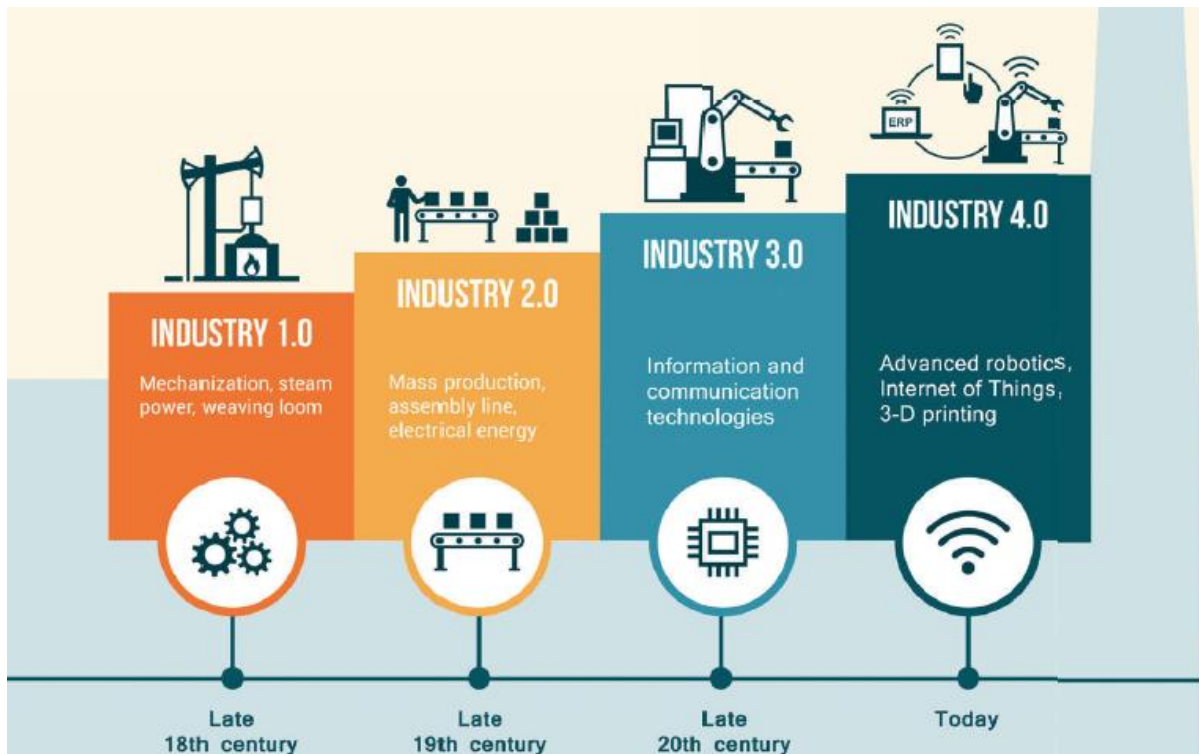


Figure 1. Industrial revolutions and shifts in manufacturing specialisation, 1784-present. Source: (Hallward-Driemeier and Nayyar, 2018)

Industry 4.0 is often described as one of the major emerging industrial trends after the global recession in the late 2000s (Bamber et al., 2017), with many industrialised countries including Germany, United Kingdom, USA, South Korea already leading the development (Roblek et al., 2016). China, the world’s leading manufacturing destination, issued the ‘Made in China 2025’ strategy partly inspired by Germany’s Industry 4.0 strategy to transform and upgrade their manufacturing industry (Zhang et al., 2016). A number of research projects have started to investigate how the benefits of industry 4.0 can be shared in the society (Buhr, 2015), and the possible challenges and opportunities for developing countries (Hallward-Driemeier and Nayyar, 2018). Yet, most discussions still remain both conceptual and technological. This industrial transformation can be detrimental to many developing countries whose main economic activities are based on labour-intensive industries where most enterprises have barely incorporated basic ICTs in their production processes (Zhang et al., 2016).

However, industry 4.0 is also happening at a smaller scale globally. An increase in digitisation and decentralisation of the manufacturing processes, combined with a democratisation of advanced manufacturing technologies, has facilitated the development of small-scale, decentralised, flexible local production network enabled by low cost digital fabrication tools and ICTs, even to providing direct manufacturing services to individuals (Hallward-Driemeier and Nayyar, 2018).

Whilst early research tended to focus more on the democratisation of technologies and their potential impact, a growing body of literature now places the emphasis beyond the technologies. One such argument is that the conditions necessary for enabling localised small-scale manufacturing and entrepreneurship appear to depend less on unfettered access to the technologies but more on access to the production system (Cautela et al., 2014; Clark, 2014; Seo-Zindy and Heeks, 2017). Yet, empirical evidence on the intersection of digital manufacturing and the possibilities of personal manufacturing is scarce (Hielscher and Smith, 2014) especially in developing countries (Seo-Zindy and Heeks, 2017).

As an attempt to fill the research gap, this paper illustrates initial findings from Vietnam, burgeoning from the development of community-led workspaces (i.e. makerspaces) and how the participants in these makerspaces are expanding the production network by working directly with individual makers, the local production partners and start-ups in the region.

### 3. Methodology

A case study is suitable when researchers cannot manipulate the behaviour of the participants and are to investigate a contemporary real-life phenomenon where the boundaries of the event and its context are not yet clearly defined (Yin, 2009). The topic in this research is contemporary and prone to quickly change over time. Hence, we adopted the qualitatively driven, explorative case study. A qualitative study will grant maximum exploratory power, especially in its flexible approach to research design, and in allowing to continuously adapt our data collection and data analysis strategies with emerging findings (Boeije, 2010). Furthermore, we have triangulated our findings and enhanced this research's validity and reliability by using mixed methods in data gathering, data analysis and the interpretation (Hesse-Biber, 2010).

Data collection took place in three steps: first, a preliminary visits of makerspaces was conducted in eight countries in Asia in 2014; secondly, a pilot fieldwork was conducted in three countries in south east Asia (Indonesia, Singapore and Vietnam) and Vietnam was chosen as a main fieldwork destination due to the rapid growths of makerspaces and small-scale electronic manufacturing; And lastly, the main fieldwork took place in three cities in Vietnam - Hanoi, Can Tho and Ho Chi Minh City(HCMC), for 20 weeks between March and July in 2017, as listed in Table 1.

Location	Duration
Hanoi	7 <sup>th</sup> of March to 22 <sup>nd</sup> of June, 2017
Can Tho	1 <sup>st</sup> to 4 <sup>th</sup> of June and 7 <sup>th</sup> to 11 <sup>th</sup> of July, 2017
HCMC	22 <sup>nd</sup> of June to 31 <sup>st</sup> of July, 2017

*Table 1 Location and duration of the core fieldwork*

Data collection included semi-structured interviews, group interviews, non-participant observation, field notes and documentary analysis. In total, 78 interviews were conducted, as detailed in Table 2. In total 83 interviewees participated in this research.

Data type	Total number
<b>Semi-structured interviews</b>	71
<b>Group interviews</b>	7

*Table 2 Total number of interviews*

The number of site visits, industrial events and workshops is detailed in Table 3. Observation and reflections from these visits were logged as an observational log.

Data type	Total number
<b>Site visits (e.g. Fablabs, factories)</b>	7
<b>Industry and networking events</b>	10
<b>Workshops (run by Fablabs, universities and government)</b>	9

*Table 3 The number of site visits/events/workshops*

For data organisation as well as for analysis, qualitative data analysis software (Nvivo) was used to systematically categorise the interview data and the participant observation data according to its thematic relevance to the core research questions. To complement coding derived from the proposed conceptual framework and other coding inductively generated in fieldwork, memos were made during the analytical stage. They reflected the methods and conceptual frameworks with displays of tables, concept map and graphical representation of the data (Miles and Huberman, 1994).

## 4. Digitalisation of small-scale production in Vietnam

### 4.1 The emerging landscape of Makerspaces in Vietnam

The development of makerspaces in Vietnam is a recent phenomenon. The first Fablab in Vietnam opened in March 2014 in HCMC and was named “Fablab Saigon”. The development of Fablab Saigon was led by a French-born Vietnamese, an ex-IT worker from France, who wanted to implement the idea of Fablabs and the maker movement in Vietnam. During the preliminary fieldwork in October 2014, Fablab Saigon was severely under equipped and under-developed. The site was mostly an empty three stories residential house on the outskirts of HCMC containing a computer, a desk, a half-built DIY 3D printer and a self-watering plant. Fablabs and maker practices were almost unheard of in Vietnam in 2014, except by some expat community members who had seen and participated in similar ventures in Europe and the US. Given the ambiguity of the regulations on community-based organisations in Vietnam (Thayer, 2009), there was even the question of how organisations like

these could be registered legally under the Vietnamese law: in particular, whether they qualified as non-profit, not-for-profit, or a business organisations.

During the pilot and main fieldwork (October 2016 and March to July 2017), 13 active makerspaces were identified in Vietnam, with most of them concentrated in Hanoi and HCM. Except for Fablab Saigon, most of the makerspaces were created late 2015-mid 2016. In other words, many of them had been operating for less than two years at the time of the fieldwork. Yet, there has been an apparent, rapid and distinctive trend as illustrated in Figure 2.

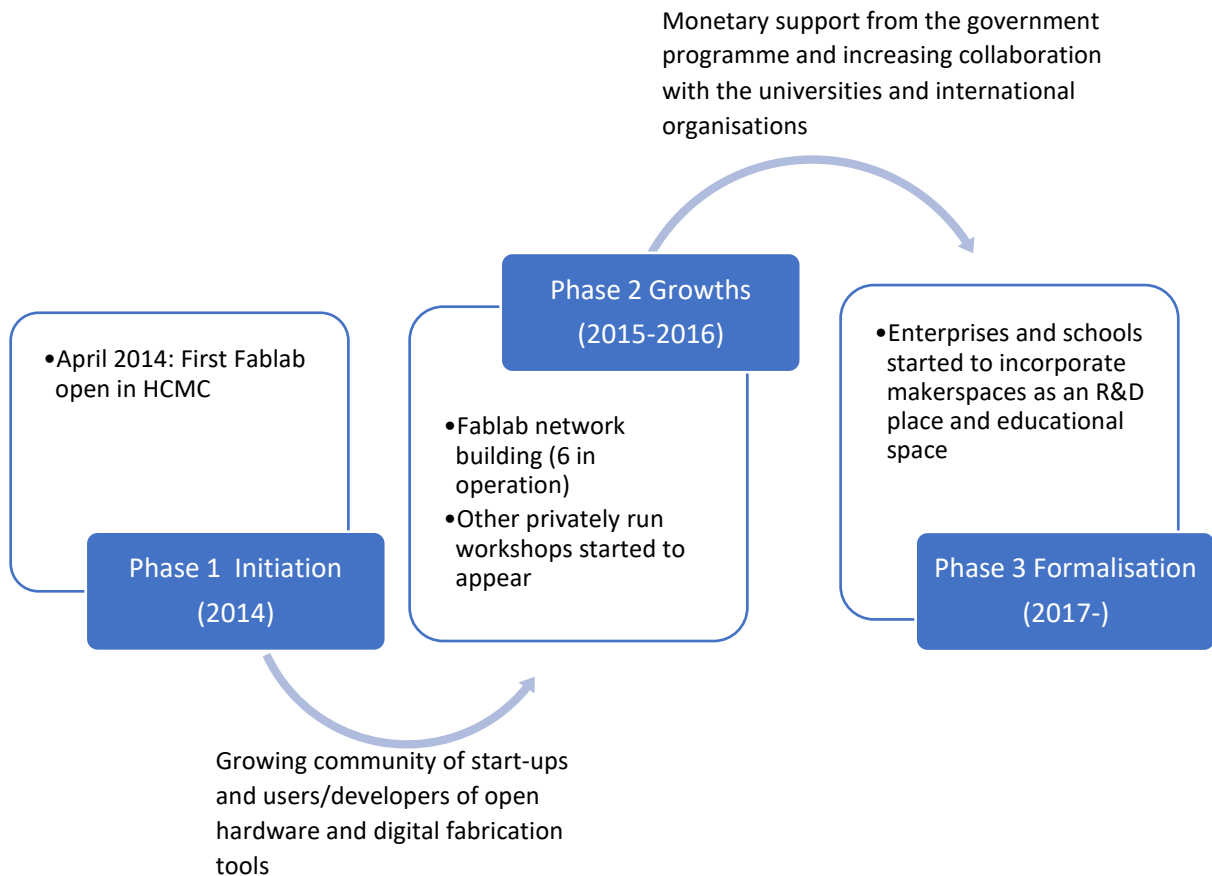


Figure 2 The development of Makerspaces/Fablabs in Vietnam from 2014 to 2017 (Source: Author's fieldwork)

Makerspaces in Vietnam have established themselves as key nodes for a multitude of services: nodes for transferring knowledge; nodes in networks of social relations and values; and nodes for connecting technical capacities. Therefore, they can be understood as sites of multiple capabilities including knowledge creation and transfer, social capital, and technology development and production. **Error! Reference source not found.** illustrates the typical actors associated with the main services that makerspaces provide in Vietnam.

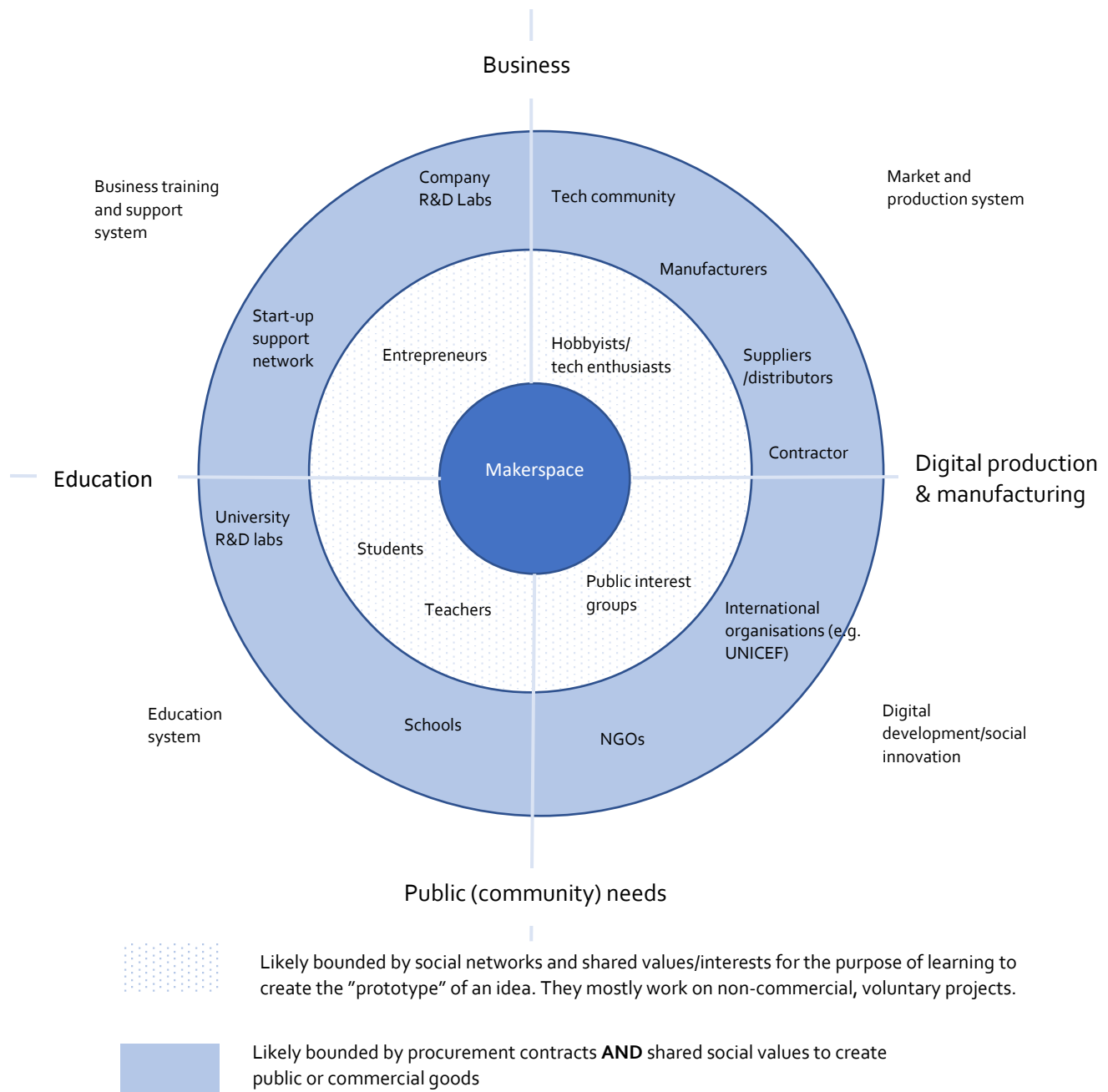


Figure 3 Typical makerspace centred ecosystem found in Vietnam (Author's construction)

The role of makerspaces as a community-based education and technical development site has been discussed in previous studies (Seo-Zindy and Heeks, 2017). However, from our analysis of Vietnam, these four defining aspects grabbed our attention: 1) locality, 2) speciality 3) connected ecosystem and 4) increasing professionalisation.

First, the development of makerspaces in Vietnam happened in urban settings where there is a high number of IT professionals or students. The actors illustrated in Figure 3 mostly resided in the city, including their production partners. Secondly, depending on local demand and size of the city, multiple makerspaces might be set up independently. Often in this case, makerspaces work together

as a loosely connected organisation. At the time of the fieldwork, each makerspace tried to find their own specialities to differentiate themselves from each other (e.g. added focus on education, environment, or commercial development), yet users (including contractors), social networks and projects are shared and assigned depending on the specialisation. Thirdly, when analysing this formation on a national scale, we find that the city-based, makerspace-centred ecosystems themselves are connected, and resources/social networks are shared openly. In other words, if a maker in Hanoi is trying to find a production partner in HCMC, their first point of contact is usually a makerspace in HCMC as there is a belief that the connections that makerspaces provide will be more trustworthy.

This brings our last point, increasing professionalisation. Initially many projects in makerspaces were developed and supported voluntarily, often on pro-bono basis or by trading favours. This model found to be not only financially unsustainable but made activities in makerspaces to be regarded as 'less' professional. At the time of the fieldwork, a rapid shift in attitudes and procedures started to appear, as written contracts increasingly replaced verbal agreements, prototypes became products, and social networks became production partners. Makerspace was increasingly becoming as a production intermediary, especially for local start-ups and SMEs.

## 4.2 Makerspace as a production intermediary

Members in makerspaces offer prototyping, manufacturing and production consultancy services for start-ups and SMEs, and are a new development in Vietnam. Initially, the services they tended to provide were simple tasks (e.g. 3d printing a single component), usually done on a pro-bono basis or for a small fee for materials for members. As they started to build a network of professionals and local production partners, services that makerspaces could potentially provide evolved towards technical consultancy. Most of their customers are people who do not have access to, or are excluded from, more formalised R&D services and manufacturing: individuals without access to labs or technical knowledge, or very early stage start-ups and SMEs with specific needs. Typical services provided to them now often include prototyping, manufacturing services and production intermediation as detailed next.

### 4.2.1 Prototyping and rapid product development

Prototyping of an idea/product is one of the most common services that makerspaces offer. The level of involvement would depend on customer's needs, from providing technical assistance to individuals (e.g. schematic diagram for electronics, PCB layout design and firmware development), to conducting technical R&D with SMEs to produce working prototypes ready to be manufactured. A Fablab manager thus described a recent project some of their team members had been working on:



*“Typically, we have a small company coming to ask with an idea. For example, we currently had a customer who asked us to develop a system that could capture the temperature and the ambient light. She ran a company that stores the vaccine and vaccine needs to be stored under certain conditions – temperature should be around 2 to 5 Celsius and it shouldn’t be exposed to light more than two or three minutes. So she was checking this by herself. But now, she is getting big customers and she cannot do this in person anymore. So, she needs to build a device [that can monitor this] and came [to us] with the idea. She doesn’t know the technical side, but she understands how it should work and what is needed. Then we help her building it. So right now, we are building a prototype for 3 samples so that she can test out how they work. If it works fine, then we can start manufacturing”.*

These are typically too niche and customised for more established companies to make, yet often too difficult to ask a repair shop to develop. It remains to be seen whether this kind of development will continue, but Makerspaces seem to answer needs of customers who would prefer a ‘cheap and workable’ solution that can be developed quickly rather than a perfectly customised product which may take longer to develop.

#### 4.2.2 Manufacturing services

Most makerspaces are equipped with 3D printers and often CNC machines which allow them to function as sites with basic level of digital manufacturing. While these machines are unsuitable for industrial-scale production, they are adequate to support one-offs up to a very small-scale production, typically less than 100 volume. This allows makerspaces to offer services including digital manufacturing, custom-made 3D design and printing for a small fee. As an indication of the price range, some fees are detailed below (Fablab Saigon, as of July 2017)<sup>1</sup>:

- 3D printing: 100k VND(£3.5) one off training then 60k VND (£2) per hour of print
- CNC machine: 100k VND(£3.5) one off training then 60k VND(£2) per hour of use
- Laser cutter: 100k VND one off training then 10k VND(£0.35) per meter of use

The projects that makerspaces are often contracted to design and produce (involving the use of 3D printing services), range from spare parts of older machinery to robot arms, and their customer base can be as diverse as shoes designers to robotic arms manufacturers. However, as the goal of makerspaces tends to be more in propping up the building capability of individuals, they tend to focus their attention on training people to design, customise or print their own products rather than

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<sup>1</sup> As an indication, a cup of coffee in a café (with a free WIFI access) costed around 20K to 60K VND during the fieldwork in Vietnam

providing simple order-to-print services. Several Fablab managers openly mentioned that they rejected the offer to make them act as order-to-print services for companies, while more commercially oriented makerspaces would see this as a potential revenue.

#### 4.2.3 Production intermediary

Most clients asking for consultancy in makerspaces are start-ups and SMEs, and the volume of manufacturing involved in producing the output is very small, ranging from 10 to 100 and rarely goes beyond 1000. As mentioned previously, self-service manufacturing can be provided by makerspaces, but they rarely have the technical and human capacities to assist with the manufacturing of bigger production volumes. Furthermore, makerspaces are usually not equipped to provide other production services such as packaging, marketing and distributions.

Products developed in makerspaces often incorporate components specifically designed or customised and may require some basic understanding of the novel technologies involved. This requires production partners who are prepared to learn and work on potentially challenging and time-consuming tasks and processes. A Fablab manager in HCMC stated as below:

*“We don't do manufacturing but we know people who can do it. We know some of the manufacturers in Vietnam well. For example, the manufacturers we know can do 100 to 500 devices and have a quality assurance. So we can trust. Then when our customer came with the small volume, we can help them out. Because we are the ones who design the device and prototype, we understand how it works when we send it to the manufacturer. It becomes easier to work.”*

As makerspaces grow in both size and reach, they gradually build relationships with local production partners who are willing to work on manufacturing small batches. Product partners identified and interviewed during the fieldwork were those who have been operating for more than a decade as electronics component suppliers or manufacturers, with contracts from both the government and large companies. For many of them, projects done in collaboration with makerspaces currently offer little monetary value, but do offer a chance to learn new technologies and be involved in developing some innovative products – especially since building a research and development lab is a luxury that many of these companies cannot afford.

#### 4.2.4 Linking foreign entrepreneurs with the local production system

A general understanding of the services potentially offered by makerspaces is growing, in particular among hardware start-ups. While most users in makerspaces are Vietnamese, it is not uncommon to see members from the expat community or foreign makers visiting makerspaces in Vietnam. And as

well as working on their own projects, they often engage with the local makers, providing advice or attending/delivering workshops to other participants in the makerspaces.

As mentioned previously, most makerspaces are run by foreign educated or foreign-born Vietnamese who can speak English. Hence, their production related services are open to both Vietnamese as well as foreign entrepreneurs and start-up companies, linking one-another with local rapid prototyping services and helping them tap into the small-scale production system in Vietnam. A Fablab manager explained:

*“A [foreign] start-up, when they have the idea but lack the skills that needed to implement, they ask us if we know so we can connect them with the right one. When they want to do manufacturing in Vietnam, they don't know where [to start] and which companies and organisations could help them. So they come here and then ask us. I also have foreign makers who come in and want to use the tools. When we don't have that [tools], they ask us for the organisation that they can go. So we connect them with other organisations in Vietnam.”*

Often, these foreign start-ups have products that are too early or too niche and finding production partners in China would be either impossible or less cost-effective for small-batch production than having them manufactured in Vietnam.

### 4.3 Beyond the makerspaces to small-scale production networks

So far, we have established that small volume manufacturing and rapid prototyping can be provided by makerspaces, in collaboration with both production partners seeking work opportunities, and local entrepreneurs wanting to develop more innovative products. This section explores the actors beyond the makerspace who form the production networks and some of the typical products that are developed within.

#### 4.3.1 Main actors in the emerging small-scale production networks

While the role of makerspaces as educational link, business support and public innovation lab were relatively well understood in Vietnam, there has been limited appreciation among active participants and policy makers of how their activities are tied together through a local/national production and innovation network. Part of the problem originates from simply looking at the immediate makerspace network rather than the wider network of actors which we illustrated in **Error!**

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Actors	Characteristics
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<b>Lead individuals/ firm</b>	Individuals or firms who initiate to develop a product. This includes SMEs who would want more customised products for their specific needs. Firms tend to focus more on serving the domestic market and the local demands.
<b>Suppliers/ distributors</b>	Dealers who sell electronics components imported from China. They tend to specialise in sourcing uncommon parts including open source hardware, IoT or 3D printing components. Suppliers are increasingly becoming distributors for some of the products that are developed in Vietnam.
<b>Manufacturer</b>	Manufacturers who are either specialised in small, niche manufacturing or willing to work for small-batch production
<b>Business support</b>	This overlaps with business development support actors in the start-up ecosystem including finance (e.g. investors, crowdfunding), business development (e.g. incubators, accelerators) and training (mentors, advisors).
<b>Makerspace</b>	Provides support and resources for initial R&D, prototyping, identifying production partners and further business development
<b>Online tech community</b>	They provide technical support and feedback but more importantly become potential customers or future developers
<b>University R&amp;D labs</b>	Individuals and firms initially borne out of the University R&D projects
<b>Private/Company R&amp;D labs</b>	Individuals and firms initially borne out of the commercial R&D projects

*Table 4 Main actors in the emerging small-scale production network*

The attributes most characteristic to the products developed in this production network are novelty (either in the product itself or the production processes), production size, and intangible assets. With a decrease in production scale and increase in product variety or diversity, costs of the product unit and production labour become higher. For production partners in this network, this is seen as an opportunity to engage in higher value added activities, upgrade their production processes and engage with the local start-ups which can produce innovative products more predominantly. Additionally, producers from makerspaces tend to seek partners who share similar values such as open innovation, community building, as well as being more ethical and environmentally friendly, or being more familiar with collaborative production processes. This is in contrasts to other hardware companies we interviewed in Vietnam which would subcontract simple assembly tasks to local

production partners whom they describe as “not even manufacturers, just a small team of manual workers”.

#### 4.3.2 Products

One of the most prominent aspects of this production network is the use and further development of what has been broadly defined at the early stage of this research as digital fabrications and other digital technologies. During the fieldwork, we found that products developed in this network can be broadly categorised as per Table . It quickly became apparent that the novelty factor of the products developed in DIFNs in Vietnam comes from integrating digital technologies (including data-driven technologies) into physical devices and processes (including manufacturing).

Product types	Product Description	Characteristics
<b>Personalised production</b>	Often one-off products assembled by hands or manufactured with 3D printer, CNC machines and laser cutters	<ul style="list-style-type: none"> <li>Made with ready-made platforms or designs</li> <li>Individuals/groups make for personal use or contracted to produce</li> </ul>
<b>Consumer-oriented hardware</b>	Many products in this category replicate or make modifications of open hardware products. Products in this category tend to be hardware focused.	companies who make and sell modified/improved version of product platforms/design
<b>Integrated solutions and niche industrial application</b>	Companies who develop and sell IoT/AI/robotics solutions. Products also tend to target specific fields such as Smart agriculture solutions for farms agriculture, education and health, etc.	While product type 2 focuses on the hardware aspect, this type of product focuses more on the integration of ICTs into physical products.

*Table 5 Typical products developed in DIFNs*

As a recent trend, digital manufacturing machineries (3D printing, CNC machines), sensors and embedded electronics systems typically used for industrial applications have all become smaller, more affordable and open sourced. The core components that enable the integration of digital elements and physical devices have been developed as “plug and play” modules in which Application Programming Interfaces (APIs) enable an easy integration of third-party products and platforms. These platforms, mostly targeting makers or non-technical users, are very basic but cheap and powerful enough to test the convergence of two or more technologies. Box 1 gives an example of one such commonly used platform developed in Vietnam.

### Box 1. Example of an IoT company in Vietnam

IoT Maker (<https://iotmaker.vn/>) produced and manufactured in Vietnam some of the earliest and most well-known Internet of Things (IoT) modules, as shown in picture 1 below.. Their platform is based around the ESP8266 and ESP32 microcontrollers from the Chinese manufacturer Espressif Systems – which are low cost and WiFi capable, with a large open-source community following. The IoT Maker modules themselves are also developed as open source / open hardware platforms.



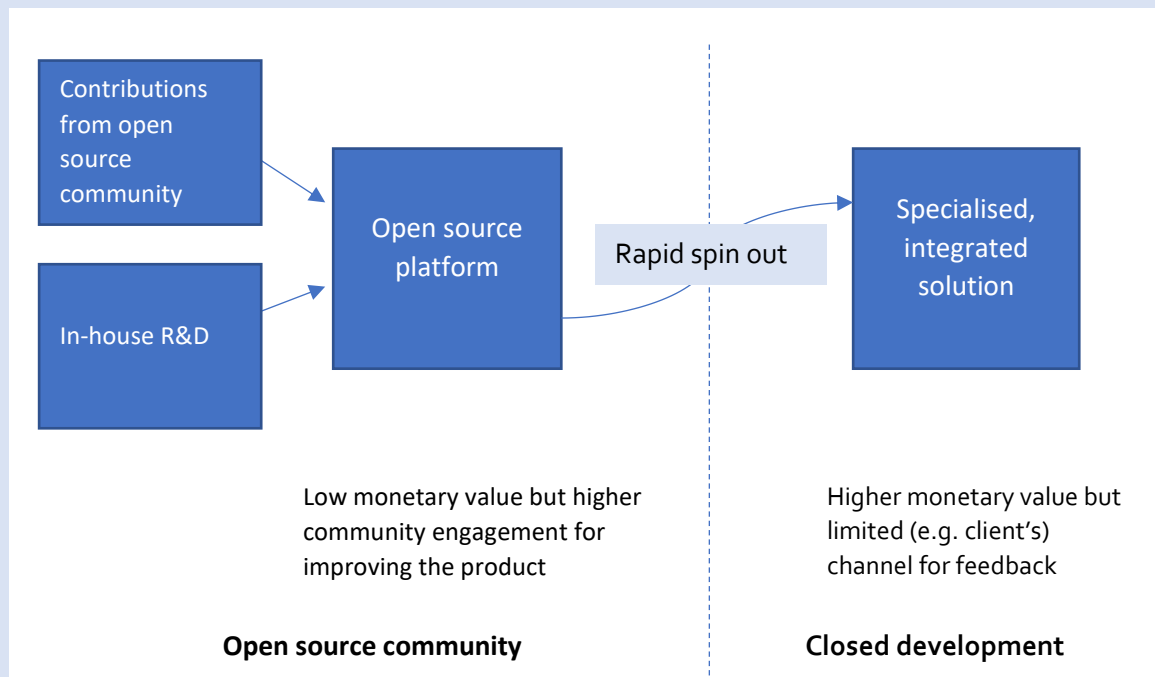
**Picture 1.**

The hardware is plug and play – meaning the different modules can be attached together or to different electronic components or devices such as WIFI, Bluetooth, sensors and be connected to a computer, either directly or through cloud services. This enables the platform to control physical devices and gather real-time data. The IoT Maker platform enables individuals and companies to prototype and test their IoT solutions much quicker than before. They cost around 250k to 500K VND (approx. £8 to £16) depending on the capabilities. This is roughly half of the price of similar modules from Adafruit or Arduino, but still more expensive than the mass produced Chinese IoT modules based on similar designs.

Given that both the maker and the users of this platform feel pride in that the modules are designed and manufactured in Vietnam, products such as these also convey symbolic value for Vietnamese makers. A small number of devoted customers will give direct feedback for further improvement, which once implemented are then shared back with the community via online forums. This provides the company with a valuable means of developing their core technologies and advance their platform. However, the products and services that the IoT Maker offer are not limited to developing opensource platforms. They also develop customised IoT solutions for bigger firms, such as developing and installing IoT in factories, however based on the very same designs (see Figure ).

Designing and manufacturing products based on the open source platform becomes relatively easy, fast and cheap. The interviewee estimated that it would take 4 to 6 weeks to design,

manufacture and distribute updated hardware to consumers. It is regarded as a relatively risk-free way to learn new technologies, develop customer base, identify production partners and establish the production process. Furthermore, some members at the IoT Maker also work at Espressif Systems as outsourced software developers and their knowledge feeds back into developing more advanced, niche industrial applications using IoT platforms. Producing prototyping tools in itself becomes prototyping the production network.



*Figure 4 Rapid prototyping and commercialisation of specialised products, stemming from an open-source platform and its surrounding open community.*

As illustrated in Box 1, lead individuals and firms which develop products in this production network in Vietnam have begun to take a more staged approach to their product development, to increasingly digitalise their products and services. Selling hardware platforms alone tend not to produce much monetary return for companies as they cannot compete against mass produced Chinese electronics. Therefore, digital service/data collection becomes more important: e.g. subscription to monitor the data/trends/device malfunction. Hence smaller digital companies are actively thinking of ways to provide digital services to generate income in a more sustained manner. Hence, devices need to be cheap to initially attract consumers, with the ulterior aim to lock their customers in their own online databases and services.

## 5. Conclusion and further research

As described previously, products developed within this network of actors in Vietnam tend to integrate digital technologies into physical devices and are manufactured through a small-scale, networked local production system. As industrial processes account for a significant proportion of this output (see Table 5), we observed that the R&D and applications of Industry 4.0 technologies normally associated with high-tech centres and industrial sites in the global North are also happening in makerspaces and small factories in Vietnam.

Typical products which we identified in Table 5 also represent different types of production processes. And while individuals who work in makerspaces may predominantly follow a personalised production, their knowledge and the network they establish can directly contribute to the firm they work for or the ones they try to create. For instance, associated firms in the network may be defined in terms of size and locality but we also found a drive to find an alternative production model that is more inclusive and innovative. Both this knowledge and the networks thus created seem for now to be openly shared within the makerspace-centred network rather than kept secret as a form of asset. As this network expands and starts to include even wider actors, more research will be needed to find out whether and how this model will evolve.



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